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STANDARDS OF MATERIALS AND WORKMANSHIP ELECTRICAL

THE MATERIALS AND WORKMANSHIP DETAILED IN THIS SECTION APPLY EVEN IF NOT DETAILED IN THE RELEVANT PARTICULAR REQUIREMENTS SECTION

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Contents

1.1 GENERAL

The Clauses described within this Section of the Specification refer to the standards of materials and installation techniques that are to be followed. The Clauses are intended to provide general guideline only and should be considered as a minimum standard acceptable to the Contract Administrator. Should any discrepancies occur between Clauses in this Section and the Particular Section, the Particular Section Clauses shall be adhered to.

The Contractor's attention is particularly drawn to the requirements of BS 7671:2018 the 18th Edition of the IET Wiring Regulations, Chapter 13, wherein only good workmanship and proper materials will be used.

The installation of all electrical works will need to be undertaken by an Electrical Contractor who is a registered Member of the National Inspection Council for Electrical Installation contracting and/or will also be a member of the Electrical Contractors Association. The Electrical Contractor will need to satisfy all requirements as necessary including Building Regulations i.e. Part 'P', for domestic installations.

Where, in the opinion of the Contract Administrator, this has not been complied with the Contractor will remedy the installation accordingly to the Contract Administrator's satisfaction.

1.2 REGULATIONS

The materials and installation procedures, which will be used throughout the Contract, will comply with the recommendations of the current Editions, including amendments of the following:

a. Wiring Regulations for Electrical Installations published by the Institute of Engineering Technology BS 7671:2018 18th Edition
b. British/European Standards and British/European Standards Code of Practice issued by the British Standards Institution.
c. The Factory Acts.
d. The Electricity Supply Regulations.
e. The Electricity at Work Regulations
f. The Health and Safety at Work Act 1974.
g. The requirements of the local Fire Protection Officer.
h. The requirements of the local Electricity Board.
i. The Gas Safety Supply Regulations.
j. The relevant Local Authorities.
k. The Construction (Design and Management) Regulations 2015.
l. The relevant Building Regulations.
m. The Control of Asbestos Regulations 2012.
n. Electricity Safety, Quality and Continuity Regulations 2002.
o. The Clean Air Acts
p. The Energy Conservation Act.

Suitable qualified operatives maintaining the current working practices shall carry out the installation.

1.3 ELECTRICITY SUPPLY

The Contractor shall be responsible for the co-ordination of the electrical services with those of the Supply Authority.

1.4 IDENTIFICATION AND NOTICES

Each conductor shall be identified at its terminations and preferably throughout its length to indicate the phase to which it is connected (reference BS 7671:2018, 18th Edition Clause 514).

Binding and sleeves for identification purposes shall comply with BS 3858 where appropriate.

Any identification of switchgear including a switchboard busbar or conductor shall comply with the requirements of BS 7671, Table 51 so far as these are applicable.

Warning notices (including 'Electrical Installation Condition Report'), Diagrams, Charts or table or equivalent form of information shall be provided in accordance with BS 7671:2018, 18th Edition (Clause 514).

1.5 CONNECTIONS TO EXISTING CIRCUITS

Where connections are to be made to the existing mains supply system no alterations shall be undertaken until first obtaining the approval of the Contract Administrator.

The work shall be executed in such a manner and at such times as may be necessary in order to cause the minimum of interference with existing services.

Where is may be necessary to interrupt existing services, notice of such intention shall be given by the Contractor to the Contract Administrator in advance to enable any necessary arrangements to be made. The notice given shall be 2 days for minor disruptions and 1 week for disruption for over 4 hours.

1.6 INSTALLATION OF SWITCHGEAR

Where individual items of switchgear are specified in the same location, they shall be grouped together or where it is suitable grouped together in a purpose made panel.

All apparatus shall be independently fixed of the wiring system.

All wiring shall be enclosed within a trunking and conduit system with no through wiring passing through any items of switchgear.

All trunking shall be provided with purpose made metal end plates and additional fixings as necessary.

No operating handle will be mounted at a height greater than 4.1 m A.F.F.L.

Surface mounted switchgear to be installed in a flush installation shall be installed over a suitably sized adaptable box. A suitable opening shall be formed in the rear of the panel for cable access.

Flush mounted switchgear to be installed within the building fabric shall be designed so as to allow full removal and replacement of all items within the panel without the requirement to damage the wall finish.

Lids shall be fully openable.

Within flush mounted distribution boards, where possible additional conduits shall be provided into the ceiling void/service duct to allow for future expansion. Minimum 2 no. conduits for each service and size provided complete with draw wire.

1.7 DISTRIBUTION BOARDS

Distribution Boards shall be of the miniature circuit breaker type complying with BS EN 60529:1992 + A2:2013 and BS EN 61439-5:2011. They shall have a fault withstand Classification of Class 1.

Each neutral bus-bar shall have an outgoing terminal for each circuit breaker type complying with BS

EN 61439-5:2011 and BS EN 60529:1992 + A2:2013 as appropriate with a degree of protection not less than IP2XC. They shall have a fault withstand Classification of Class 1.

Each neutral bus-bar shall have an outgoing terminal for each neutral conductor connected to it. Connections to the neutral shall be arranged in the same order as the outgoing live circuit conductors.

Bus-bars shall be in the same position relative to their fuse carriers or MCBs for each pole. A multi-terminal bar for the circuit protective conductors shall be provided for both insulated and metal cased boards with one terminal for each outgoing circuit. It shall be directly connected to the earthing terminal without depending on the exposed conductive parts of the enclosure.

Identification of each fuseway and MCB way shall be by numbering. Identification on the neutral bus-bar and protective conductor shall clearly relate each terminal to its respective fuseway/MCB or RCBO way.

Number of spare fuse/MCB/RCBO ways shall be provided where indicated. If not indicated a minimum 20% spare ways shall be provided. Where specific ratings are indicated, fuses/MCB's/RCBO's shall be incorporated, otherwise the ways shall be left blank but suitable for future additions.

Distribution boards are to include an integral, suitably rated switch. Phase barriers shall also be fitted as necessary.

1.8 MINIATURE CIRCUIT BREAKERS (MCB'S)

Miniature circuit breakers (MCBs) shall be complete with suitable voltage and ratings selected in accordance with the size of sub-circuit wiring in accordance with the IET Wiring Regulations. They shall be either single or triple pole and shall comply with BS EN 60898 latest edition and amendments.

Unless stated otherwise, miniature circuit breakers shall have a minimum rated breaking capacity of M6. Combined MCB/RCCB (Residual Current Circuit Breaker) with over current protection (RCCBO) shall comply with BS EN 61008-1:2012 + A2: 2013. Unless stated otherwise all RCCBO units shall be of type C characteristics and set at 30MA tripping sensitivity.

1.9 MOULDED CASE CIRCUIT BREAKERS (MCCB'S)

Moulded case circuit breakers shall comply with BS EN 60947-2:2006 + A2:2013 (Latest editions and amendments). They shall have the voltage and current ratings, rated duty, rated short circuit breaking capacity and rated short time to withstand current as required in accordance with the IET Wiring Regulations.

MCCBs shall be of the independent, manual closing air breaker type, rated for an uninterrupted duty unless otherwise indicated.

Auxiliary facilities including power closing and under voltage releases shall be provided only where indicated.

Each MCCB shall have a facility for padlocking in the 'OFF' position.

1.10 FUSES

The type and current rating of fuses shall be as required and/or indicated.

Cartridge fuse links complying with BS 1361 shall by Type 1 fuse carriers, bases and associated parts shall also comply with BS 1361 (latest additions and amendments).

Cartridge fuse links complying with BS 88 shall have a fusing factor of Class Q1 unless otherwise indicated.

Motor circuit fuse links shall by used only where indicated or where necessary. Fuse carriers, bases and associated parts shall also comply with BS 88.

1.11 AIR CIRCUIT BREAKERS (ACB'S)

Air break switches shall comply with BS EN 60947. They shall have uninterrupted duty, a mechanical endurance not less than those set out in the relevant table(s) of BS EN 60947, and utilisation category of AC-22 or AC-23 as indicated.

Switches shall meet the requirements of switch-disconnectors. Each switch shall have a facility for padlocking in the 'OFF' position.

1.12 CONTACTORS

Contactors shall comply with BS 5424 & BS EN 60947-4-1:2010 + A1:2012. They shall be air-break type and have the voltage and current ratings, type of duty, utilisation category and electrical endurance as required.

Contactors shall be electromagnetic, suitable for the control arrangements as required. Operating coils shall be suitable for D.C. and a rectifier shall be incorporated for A.C. control circuits, protected by low current cartridge fuses.

Latch-in contactors shall be provided only where indicated.

1.13 CABLES AND GENERAL REQUIREMENTS

All cables shall be of the low smoke and fume (LSF) type with thermosetting insulation (XL).

All cables will have copper conductors, unless specified otherwise, and comply with the appropriate British Standard Specification, and BASEC approval. Where applicable, type and size of cables will be as specified on the Drawings and Schedules.

Unless otherwise specified, no cables of less than 1.5mm² C.S.A. will be used. The use of solid core cables is prohibited (unless flat 6242Y or 6243Y cables are being used). The cables shall be installed without joints.

Unless particularly detailed in this Specification or Drawings, cables will not run through lighting fittings.

Cables shall be coloured as follows:

Phase cables on single-phase circuits:	Brown
Phase cables on three phase circuits: phase to which it is connected	Brown, Black, Grey corresponding to the
Neutral cables throughout:	Blue
Low voltage cables:	Brown
Circuit Protective Conductor:	Green or Green/Yellow

Every cable and flexible cord shall bear the following markings to signify that it's a product of authenticity:

a. Manufacturers Origin Mark – all cable should bear a manufacturers name.
b. British Standard Number – by marking the cable with this standard number, the manufacturer has confirmed conformity to this standard. This amounts to a claim by or on behalf of the manufacturer that the product meets the requirement of the standard. The accuracy of this claim is solely the claimants and it should not be confused with 3rd party accreditation.
c. BASEC Marking – this is only allowable if the cable has been tested by BASEC and continues to meet the surveillance requirements.

d. Harmonised Cable Mark and Harmonised Designation – as a part of the pan European CENELEC harmonisation scheme, these markings denote that the cable is harmonised. HAR is a voluntary mark which signifies a quality code.
e. Conductor Size – the cross sectional area of the copper conductor.
f. Year Letter – a letter attributable to the year of manufacture.
g. Origin of Manufacture – country of origin.
h. Harmonised Core Colours.

All cables used in the installation shall be based certified.

The cables and seals will be intact when delivered on site. No coil, cable or flexible cord manufactured more than one year prior to delivery on the site shall be used in the installation.

Before wiring the conduit/trunking enclosure shall be complete, free of dirt, water and condensation.

Where cables are concealed in flush conduits the cables will be installed easily via draw boxes so that the cables can be withdrawn or rewired without disturbance to the building fabric.

Cables will always be so bunched that cables of all phases and neutral are drawn into the same conduit.

The conduit cable capacities laid down in Appendix 5 of the On Site Guide will be strictly adhered to.

All cables shall be installed in strict accordance with BS 7671:2018, 18th Edition, latest edition and amendments.

The installation of cables shall not commence until the building is sufficiently enclosed to ensure permanently dry conditions. Cables shall be adequately protected at all times during the contract period against accidental damage, adverse environmental conditions, mechanical stress and deleterious substances.

Cables shall be installed neatly and securely without joints other that at equipment and terminal fittings. Junction boxes shall not be used without approval from the Contract Administrator.

No reduction of cable strands forming the conductor shall be allowed at switch or other terminals. All strands shall be efficiently secured by screws, nuts and washers or other approved means.

All cable lengths stated on the drawings or in the cable schedules are for design purposes only and shall not be used for Tender or Construction. Unless stated otherwise, specified three phase cable groups or single core cables shall be laid in trefoil formation and touching each other. During installation no cable shall be bent to a radius smaller than the minimum recommended by the manufacturer.

1.14 XL-LSF SINGLE CORE CABLES

All XL-LSF single core cables will be protected throughout their length by heavy gauge conduit mini trunking or steel trunking.

All single core cables will have copper stranded conductors and for normal conditions will be XL-LSF insulated.

The XL-LSF cables will fully comply with BS 7211:2012 and will be of 600/1000V rating.

1.15 FLAT XL-LSF AND SHEATHED CABLES

These cables will be copper conducted XL-LSF insulated and sheathed, twin and earth or three core and earth conforming to BS 7211:2012 and BS 6346: 1997.

The use of cables with phase conductors having a cross-sectional area of less than 1.5mm² is prohibited. Where 2.5mm² XL-LSF insulated and sheathed cables are used, the circuit protective conductor will not have a cross-sectional area of less than 1.5mm².

Wiring will be carried out on a "loop-in, loop-out" system with all cables terminating directly within main switches, distribution boards, etc., socket outlets, luminaires and switches only. Joints made within junction boxes and the use of through joints will not be permitted.

Cables will be concealed as far as possible in accessible roof spaces and under floors, where they will be run parallel, or at right angles to all joists, etc.

Cables in the roof void will be secured to the sides of the joist by means of plastic cable clips at not more than 250mm centres and will be secured to battens when running across the joist.

All cables will be installed not less than 100mm clear of any gas, heating, hot water or steam pipes, radiators or other heated fittings, except where the pipe or fittings are effectively insulated and, in this instance, a 10mm air gap will be provided between the insulation and the cables.

All cables will be dressed flat; will be free from twists, kinks and mechanical strain.

Cables shall be installed to satisfy the requirements of BS 7671:2018, 18th Edition (latest amendment) and Part P of the Building Regulations for installations within domestic premises.

The conduit shall run from a position inside the accessory box and will extend into the floor or roof space for at least 50mm. The conduit will terminate in the accessory box by means of a PVC adapter and screwed male bush.

PVC adapters/accessories for non-metallic conduits.

The ends of the conduits will be finished so as to prevent abrasion of the cable installation when cables are being drawn into or out of conduits or connected to apparatus.

Cables passing through walls or concrete floors will be enclosed in PVC conduits.

Where it is not possible to conceal the cables in walls, etc., they will be installed on the surface, but in these instances, surface mounted conduits or mini trunking will protect them.

Cables terminating at ceiling switches or luminaire points will terminate within a standard besa box complete with fixed earth terminal and 51mm fixing centres, complying with BS 4568-1:1970 & BS EN 61386-1:2008.

Where standard besa boxes are installed within plaster ceiling they will be securely fixed to wooden noggins provided and installed by the Contractor a sufficient height above the ceiling to permit the face of the box to be flush with the finished ceiling surface.

Where wall or ceiling mounted luminaires and ceiling mounted switches are installed the fixed wiring will terminate directly into the accessory terminals.

1.16 MINERAL INSULATED COPPER CONDUCTED CABLES

Where M.I.C.C. cables are specified within this Specification and/or on the accompanying Tender Drawings, this will mean mineral insulated copper sheathed cables manufactured in accordance with BS 6207-1: 1995 & BS EN 60702-2:2002 + A1:2015 and all relevant later amendments.

Generally cables will be light duty, rated at 600V, and may be used for fire alarms, general lighting and small power circuits. Heavy-duty cables, rated at 1000V, will be used for all other services.

Cable terminations will comply with the requirements of BS 6207-2:1995 and comprise ring type glands, screw on pot type seals, cold plastic compound suitably for temperatures up to 105°C, anchoring bends and neoprene sleeving. The Contractor will terminate M.I.C.C. cables in an approved manner and procedure recommended by the cable manufacturer.

All seals and lengths of M.I.C.C. cable shall be tested not less than 24 hours after completion with a megger insulation test at a pressure not less than 500 volts. Nothing less than an infinity reading must be obtained between any conductors and the cable sheath, all conductors being disconnected from any apparatus. All M.I.C.C. cables requiring to be "covered up" shall be tested before and after "covering up".

The specified tools recommended by the manufacturer will be used throughout the installation.

The Contractor at their cost will rectify low insulation resistance readings due to faulty cable termination procedures.

Before proceeding with the installation of MICC cables the Contractor may be required to demonstrate to the Contract Administrator the ability on their site personnel to apply a complete termination to one end of an installed cable.

All conductor tails will be marked with coloured sleeves of an approved pattern to identify the conductors.

The colours used will be in accordance with the recommendations of the latest Edition of the IET Regulations.

Sub-main cable conductors will be marked with coloured sleeves indicating the colour phase they originate from.

All M.I.C.C. cables will be securely fixed by single or multiple heavy gauge saddles to the surfaces of the walls, ceilings, ducts, etc., by 25mm No. 6 round head brass screws.

Where several cables are installed together multiple saddles shall be used only.

Where cables are to be supported onto a perforated cable tray the fixing screws will be round head brass to comply with BS 450 and the securing nuts will be of the brass square pressed type complying with BS 2827.

The spacing of saddles or clips will not exceed the distances indicated below:

a)	Cables up to 9mm overall diameter single or multi-bank:	230mm
b)	Cables of over 9mm diameter up to 12mm overall diameter, single or multi-bank:	300mm
c)	Cables of 12mm overall diameter and greater, single or multi-bank:	375mm
d)	Multi-bank saddles containing cables of various sizes, will be directed on site by the Contract Administrator but on no account will they exceed:	375mm

Cable bends will not be less than six times the diameter of the cable. At terminations, there will be at least 75mm of straight cable at the gland position.

Where surface cables rise through floors to serve an accessory point, the cable will be protected through the floor up to a height of 2M above f.f.l. with heavy gauge galvanised conduit. The space between the cables and conduit in each instance will be filled with cold setting mastic compound.

Where cables pass through any structure, e.g. walls and floors, these cables will be protected by heavy gauge galvanised conduit provided with female brass bushes at either end of the conduit.

M.I.C.C. cables provided with a PVC outer sheath would be provided to the following exposed corrosive atmospheres:

a. Damp situations, i.e. externally run cables.
b. Boiler houses/plant rooms.
c. Service ducts.
d. Embedded within plaster or floor screeds.
e. Secured to cable trays.
f. In areas specifically specified within the specific section of this Specification and Contract Drawings.

Where PVC sheathed cables are installed a PVC shroud will also be employed.

All cables will terminate directly into main switches, BS besa boxes, socket outlet boxes and fixed apparatus only.

No joints will be allowed in joint boxes, nor will any through joints be allowed, unless as specifically instructed by the Contract Administrator.

Where M.I.C.C. cables terminate directly into luminaires or BS besa boxes to which luminaires will be directly attached, high temperature sleeving will be used to protect the conductors.

Where M.I.C.C. cables terminate within accessory boxes in damp situations the boxes will be of the watertight pattern with tapped thread entries, external fixing lugs and machine faced.

lids. The lids will be rendered watertight by means of waterproof jointing compound or rubber gaskets. In no circumstances will it be permissible to drill boxes internally for fixings.

Where surface mounted run M.I.C.C. cables terminate within a plain hole accessory box, i.e. switch, socket outlet or distribution board, etc., the cable will terminate with the use of internally threaded space ranger glands provided with brass locknuts and zinc plated lock washers (where applicable).

M.I.C.C. cables terminating direct to apparatus which will be subject to vibration or which is adjustable, i.e. motors or pumps will be formed into a double turn loop coil immediately prior to the termination.

Where M.I.C.C. terminates within PVC accessory boxes suitable earth tail pots or earthing rings shall be used to ensure earth continuity.

1.17 XL-LSF INSULATED AND SHEATHED STEEL WIRED ARMOURED CABLES

Where XLPE/SWA/LSF cables are specified within the specific section of this Specification and/or indicated on the accompanying Tender Drawings. This will mean PVC insulated and sheathed steel wired armoured cables.

All XLPE/SWA/LSF cables are to be of the 600/1000 volts grade, unless otherwise specified, and will comply with the requirements of BS 6346:1997 for copper cables.

The conductors will be of high conductivity copper wire (unless specified otherwise) insulated with PVC compounds, the cores laid up with PVC textile filler, PVC sheathed or textile bedded, armoured with a single layer of galvanised steel wire and PVC serviced overall.

Cores shall be identified as follows:

Twin core cable	-	One core brown and one core blue
Three core cable	-	One core brown, black and grey
Four core cable	-	One brown, black, grey and blue

All cables shall be installed in one length without intermediate joints. The minimum installation temperature is 0°C. If cables are being installed during sub-zero temperature conditions, they should be stored at a temperature above freezing point for at least 24 hours immediately prior to handling.

Each cable shall be marked at both ends with white ivorene or traffolyte engraved labels denoting cable size.

The ends of all cables shall be terminated by means of compression type glands complete with earth terminating rings and PVC shrouds. These glands shall be of the same manufacture as the cable.

The earth terminating rings will be securely bolted to the electrical apparatus with the use of brass round headed screws and nuts complying with their respective British Standards. Within the electrical apparatus an earth fly lead will extend from the earth ring with the use of crimp lugs and terminate within the earth terminal of the apparatus.

Cables shall be installed throughout with the greatest possible care and any damage caused to the cable during installation or the progress of the work will necessitate the rejection of the cable and the replacement and re-erection of a corresponding new length by the Contractor free of charge.

Where cables are to be run on the surface they shall be supported by means of claw type cleats, as manufactured by BICC Ltd, or equal and approved, and the spacing of the supports must not be greater than those given in the following Tables:

Overall Diameter of Cables *	Non-armoured rubber, PVC or lead sheathed cables		Armoured cables and corrugated aluminium sheathed cables.		Mineral insulated copper sheathed or aluminium sheathed cables	
	Horizontal	Vertical	Horizontal	Vertical	Horizontal	Vertical
Not exceeding 9	250	400			600	800
Exceeding 9 but not 15	300	400	350	450	900	1200
Exceeding 15 but not 20	350	450	400	550	1500	2000
Exceeding 20 but not 40	400	550	450	600		
Exceeding 40 but not 50	600	800	900	1100		
Exceeding 50 but not 60	750	1000	950	1100		
Exceeding 60 but not 70	900	1200	1000	1200		
Exceeding 70 and above	1000	1400	1200	1400		

* Normal practice is to consult the cable manufacturer about support spacing on cables exceeding 40mm diameter. The space for horizontal runs may be applied also to runs at an angle of more than 30º from vertical. For runs at an angle of 30º or less from the vertical, the vertical spacing is applicable. In long straight heavily loaded power cable installations, either loop the cables at suitable intervals or increase the cable spacing by a factor of 1.5. Where the appearance of the cable installation is not important, the spacing could similarly be increased by a factor of 1.5.

Where the cables pass through walls or floors of fire zones the holes shall be filled with fire resisting

infill after the installation of the cables.

Each cable shall be protected from mechanical damage to a height of 2 m above floor level, where run on the surface of walls.

Where cable access to buildings is required the cables shall be run in short lengths of glazed earthenware or PVC cable ducts to ensure that the cables are not damaged when drawn into the duct. The entry point is sealed to prevent ingress of moisture and vermin.

The Contractor will allow for all abnormal brackets required for cradle support on site. The Contractor will also allow for drilling of installed steelwork to take the studs for the cleats.

Cables will not be bent during installation to a radius smaller than eight times the overall cable diameter.

Cables will be segregated from the finished face of other services by a minimum distance of 75mm, unless as instructed by the Contract Administrator.
Cables laid directly in the ground will be installed to a depth of not less than 600mm below finished ground level.

In normal soil the cable will be laid on 100mm of sand and covered with a minimum of 150mm of sand and taped over its entire length underground. The Contractor must include for supplying and laying of the same and protection tape, the latter to be laid at a depth of 300mm below ground level. The protection tape shall have the following words printed thereon:

"CAUTION - ELECTRIC CABLES BELOW"

Before the cable is finally covered the Contract Administrator will be invited to inspect the cable along its entire length.

Where cables are to be run under paths, paved roadways or enter buildings, they will be drawn into earthenware ducts which shall be provided and laid by the Contractor to a depth of not less than 600mm, below finished ground level. All duct terminations in buildings will be made with the use of manufactured easi bends.

Cables shall also be protected by earthenware ducts where they cross the route of the other services, to a minimum of 600mm each side of the crossing points.

Purpose made concrete cable markers laid flush with the finished surface will be supplied and installed by the Contractor to indicate cable routes.

The use of underground cable joints will only be permitted by written instruction by the Contract Administrator or specifically called for within the specific section of this Specification and/or Tender Drawings.

All underground cable joints shall be made by a proficient cable jointer using cast iron joint boxes and suitable resin compound to the strict recommendations of the cable manufacturer.

1.18 FLEXIBLE CABLES AND CORDS

Flexible cords in dwellings will be 300 volt grade single phase and in all other instances will be 300/500 volt grade single and three phase complying fully with BS 6500:2000.

Conductors will be plain annealed copper strand for PVC cords and will be tinned annealed copper strand for elastomeric cords.

The conductors will be insulated with PVC (HR), EPR or silicone rubber.

Cores will be laid up and the interstices filled where necessary with suitable filling for the working

temperature of the cable and sheathed with PVC (HR), HOFR hypalon or CSP.

Flexible cables will be of circular type.

The cores of each flexible cable will be identified as follows:

NUMBER OF CORES	FUNCTION OF CORES	COLOUR(S) OF CORE
2	Phase conductor Neutral conductor	Brown Blue
3	Phase conductor Neutral conductor Protective conductor	Brown Blue Green & Yellow
4 or 5	Phase conductor Neutral conductor Protective conductor	Brown or Black Blue Green & Yellow

The weight supported by any flexible cord shall not exceed 3 kg for 0.75mm² or 5 kg for 1.5mm².

Where excessive temperatures may be encountered with the use of tungsten coiled lamps mounted within luminaires, PVC flexible cords shall conform to BS 6500:2000 (latest edition and amendments).

1.19 CABLE TRUNKING SYSTEMS

The cable trunking used throughout the installation will be manufactured from galvanised sheet steel and constructed to conform with the requirements of BS 4678 including Part 4:1982 (latest edition and amendments).

Trunking sizes up to and including 150mm x 50mm, or equal, cross-sectional area is to be produced from 1.2mm minimum thickness sheet steel, above these sizes 1.6mm minimum thickness sheet steel will be employed.

Cover lids will be fastened to the trunking body with turnbuckle screws rigidly secured to the inwardly turned flanges on the trunking body.

All straight trunking joints will be made with the use of purpose made coupler connectors secured with electro-tinned screws, nuts and shake-proof washers.

Trunking accessories will comprise gusset type bends, tees and angles of similar gauge, type and manufacturer as the trunking body.
All trunking and accessories will be provided with a hot dip galvanised finish to comply with BS EN 10143:2006.

Fabrication of any components on site is prohibited and only the manufacturers listed accessories will be accepted.

All trunking will be made continuous electrically and mechanically by means of copper links across each joint on the system. The galvanising material will be removed within 6mm of the jointing strap to ensure good earth continuity.

Vertical sections of trunking will be provided with pin racks at not more than 2M intervals.

Continuous sheet steel segregation barriers will be provided, securely fixed to segregate final sub-circuits and ancillary circuits, i.e. telephone and door porter systems.

Purpose made fire barriers shall be inserted into sections of trunking at points of entry and exit from roof spaces between rooms and floors.

Where trunking passes through holes in the building structure, a cover plate will be fixed to the face of the trunking before installation and will be arranged to project at least 50mm beyond the finished structure.

Where trunking is to be used to connect switchgear or fuse boards, such connections will be made by trunking fittings manufactured for this purpose and not by multiple conduit coupling.

Due allowance shall be made for expansion on long lengths of installed trunking.

The cable trunking will have a total air space of 66% giving a cable carrying capacity of 34% within the internal area of the trunking.

All trunking will be rigidly attached to the building fabric at intervals not exceeding the following Tables:

Cross-sectional Area Of Trunking	Maximum Distance Between Supports For Metal Trunking	
	Horizontal	Vertical
Exceeding 300mm² and not exceeding 700mm²	750mm	1000mm
Exceeding 300mm² and not exceeding 1500mm²	1250mm	1500mm
Exceeding 1500mm² and not exceeding 2500mm²	1500mm	2000mm
Exceeding 2500mm² and not exceeding 3500mm²	1500mm	2000mm
Exceeding 5000mm²	1500mm	2000mm

Fixings will be provided within 300mm intervals of all bends, angles and fittings. Small individual pieces of trunking will be independently supported accordingly.

All trunkings will be fixed by means of round head wood screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length 32mm x No. 10 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008 and BS EN ISO 2082:2008.

Each final sub-circuit contained within trunkings will be taped at 600mm intervals with two laps of good quality transparent tape with additional wrapping at bends.

Circuit identification tapes will be attached under one layer of transparent tape at 4M intervals.

1.20 CABLE TRAY

Cable trays shall comprise of perforated steel pre-galvanised manufactured to BS 2989 bending and profiling quality.

The cable tray shall have return flanges and comprise of the following thickness:

Up to & including 100mm wide	-	0.9mm
Up to & including 150mm wide	-	1.25mm
Up to & including 300mm wide	-	1.6mm
Above 300mm wide	-	4.0mm

The tray shall be galvanised for internal applications unless indicated elsewhere in the Specification.

The cable tray accessories to be installed shall be of the same specification as the cable tray.

All joints shall be made using manufactured fishplates, shouldered ends and couplers with galvanised or zinc plated slotted domed head roofing bolts.

All flat bends and intersections shall be of the gusseted type.

The tray shall be supported by purpose made galvanised brackets at intervals not exceeding 1200mm and 230mm from all fittings and with a minimum 20mm clearance behind the cable tray.

The brackets shall be securely fixed to the building fabric using suitably sized masonry plugs and screws. The screws shall be zinc plated (electro galvanised) complying with BS EN ISO 2081:2008 and BS EN ISO 2082:2008 Class B coating and be no less than 32mm x No. 8 in size.

The tray shall be fixed to the galvanised brackets using zinc plated slotted domed head roofing bolts.

Cable tray shall only be cut along a line of plain metal and all cut edges of galvanised cable tray shall be prepared and treated with a zinc rich paint, primer and top coat.

Holes cut in cable tray to allow cable to pass through shall be suitably bushed.

The cables shall be fixed to the tray by means of proprietary form of plastic or copper cable clips, saddles, strips or ties. When installed in situations where high temperatures or humid conditions are likely to occur copper or brass saddles and clips shall be used.

All saddles, clips, straps, etc., shall be fixed to the tray by means of brass screws or nuts and bolts.

1.21 PVC MINIATURE TRUNKING ARRANGEMENT

PVC miniature trunking will be of the high impact quality conforming to the requirements of BS 4678: Part 4:1982.

PVC trunking and accessories will not be installed where the temperature falls below -5°C or exceeds 60°C.

The trunking will be fixed at centres not exceeding 300mm by means of round head steel screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum size of 32mm x No. 8 screws.

Each section of trunking will be fixed not more than 32mm from each end, corner or accessory.

All cutting of trunking will be neat, clean and square and the manufacturers purpose made junction units, connections, tee angles and joints will be used to the complete satisfaction of the Contract Administrator.

All trunking will be run between final positions of accessories, walls, ceilings, etc., and will not terminate in mid run despite reduction in the number of cables. Where necessary high- level trunking will be extended in dummy lengths from the ends of cable runs to the next change of direction of wall and/or ceiling.

Trunking will be run close to corners of the room, building structure, chimney breast corners, built-in corners, etc., and the general finish will be as unobtrusive as possible. It is preferable to run the trunking in an adjacent bedroom or other room in order to avoid trunking runs in the Living Room.

Where the trunking turns at right angle in the dwelling the junction will be made in an approved manner or a manufactured junction used, so that the turn is made without cutting the back of the trunking.

Trunking will only be run vertically or horizontally.

After final installation of all lids, the trunking will be cleaned using a mild detergent.

Where trunking runs are obstructed by picture rails small simple cornices, etc., the obstructions will be neatly cut to fit close to the sides of the trunking and, where necessary, the cut obstruction will be re-fixed. Where an item that cannot be cut obstructs the trunking, then the trunking will terminate either side of the obstruction and the cable recessed behind the obstruction.

At all terminations purpose made adapters are to be used-switches, socket outlets, fused spur units, cooker control units, immersion heater (adaptable box), etc.

At lighting points however a shallow moulded box will be used, together with a break joint ring made from white plastic, robustly constructed and provided with suitable cable entries and ample room for slack cable.

Where cable runs pass through walls, a suitable length of size of PVC trunking or conduit will be run through the wall and be cemented into the base of the trunking on each side of the wall. No trunking or oval conduit will be visible when the installation is complete.

The number of cables enclosed in PVC miniature trunking will not exceed the following:

Trunking Size	1.5mm² T & E x L-LSF T&E	XL-LSF	2.5mm² T&E	XL-LSF
16mm x 16mm	1	8	-	7
16mm x 25mm	2	14	1	11
16mm x 38mm/40mm	3	24	2	19
25mm x 38mm/40mm		42	4	33

PVC miniature trunking will be spaced as far as practical from steam, water, gas or other services with a minimum clearance of 50mm between services. Where installed PVC miniature trunking are located in close proximity to other services, the trunking will be provided with a heat barrier and securely fixed to avoid contact.

1.22 STEEL CONDUIT AND CONDUIT FITTINGS AND ACCESSORIES

All steel conduit and conduit accessories used throughout the installation will be manufactured by comply with the requirements of BS EN 61386-1:2008, the Specification for Steel Conduit & Fittings with Metric Threads of ISO Form for Electrical Installations, Steel Conduits, Bends & Couplers, Fittings & Components, together with all amendments.

All steel conduits will be heavy gauge screwed and seam welded medium protection Class 2 for stove black enamelled type conduit and Class 4 hot dipped for galvanised type conduit.

All steel conduits to be installed will not be less than 20mm diameter and will not exceed 32mm diameter unless specifically specified within this Specification or as indicated on the Contract Drawings or by written instruction by the Contract Administrator.

All steel conduits and conduit accessories, i.e. fittings, adaptable boxes, saddles, etc., will match the type of conduit specified and will be of the same manufacturer.

Each steel conduit installation where applicable will be installed to comply with the requirements of BS EN 61386-1:2008:, BS EN 61386-21:2004 + A11:2010 and BS EN 61386-24:2010.

Conduit screw threads will be of the ISO Form and will be cut by means of efficient sharp stocks and dies. Under no circumstances will broken or loose threads be accepted.

Where practicable, all threads will be half the length of the appropriate standard straight coupler and no thread will be exposed, except at "running couplers". In these instances the exposed threads will be painted immediately after installation.

All threads will be cleaned and free from oil prior to installation and all threads will be thoroughly clean and free from paint, enamel, dirt, grease, etc. All steel conduits will be free from rust patches and mechanical damage on delivery to site. The steel conduits will be stored in a dry and secured area to maintain an acceptable quality as previously specified.

All conduit threads will be cut "wet" with high conductivity graphite paste or metallic paste having a non-insulating binder.

1.22.1 Circular Conduit Boxes

BS circular boxes will be manufactured from malleable iron with internal dimensions 60.3mm diameter x 28.5mm depth and cover fixing lugs at 50.8mm centres. Each box will be provided with a tapped hole in the base of the box for a M4 earth screw.

BS circular boxes will be fitted with a flat circular steel cover plate fixed by 2 No. round raised head M4 screws. Where the boxes are flush mounted, the cover plate will be of the overlapping type.

Where BS circular boxes are installed to external areas, moisture and semi-exposed situation each box will be provided with a rubber gasket sited between the outer ring of the box and the cover lid.

All BS circular boxes will be fixed to the building fabric by means of 2 No. round head screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32mm x No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008, BS EN ISO 2082:2008 Class B coating.

1.22.2 Adaptable Boxes

Adaptable boxes will be manufactured from heavy gauge rust proofed mild steel, fully welded seams and heavy gauge flat flanged lids. The width gauge will be as follows:

Boxes up to 150mm x 150mm x 75mm:	14 gauge
Boxes up to 355mm x 354mm x 100mm:	12 gauge

Each box will be manufactured with plain sides necessitating drilling of holes on site; the use of knockout boxes is prohibited.

Adaptable boxes installed to external, moisture and semi-exposed areas will be galvanised and provided with rubber gaskets situated between the outer face of the box and the lid.

All adaptable boxes will be fixed to the building fabric by means of 4 No. round head screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32mm x No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008, BS EN ISO 2082:2008 Class B coating.

Earthed steel barriers will be provided where necessary to suitably segregate services.

1.22.3 Conduit Distance Saddles

Surface mounted steel conduit will be rigidly secured to the building structure with the use of heavy gauge distance saddles provided with 2 No. M4 metric roundhead brass screws securing the saddle clip to the base ensuring the conduit standards not less than 6mm clear from the building surface.

Each distance saddle will be fixed to the building structure by means of 1 No. counter-sunk screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32mm x No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008, BS EN ISO 2082:2008 Class B coating. Distance saddles will be provided within 300mm either side of each steel conduit bend or set and at a maximum distance of 900mm between saddle centres for straight sections.

Where conduit boxes, accessories, etc., are situated distance saddles will be provided 300mm either side from the centre of the box.

The Contractor will carefully arrange the layout of the saddles to achieve an even workmanship and aesthetically pleasing appearance.

1.22.4 Conduit Spacer Bar Saddles

Surface mounted steel conduit will be rigidly secured to the building structure with the use of heavy gauge spacer bar saddles provided with two No. M4 metric roundhead brass screws securing the saddle clip to the base.

Each saddle will be fixed to the building structure by means of 1 No. counter-sunk screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32mm X No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008, BS EN ISO 2082:2008 Class B coating.

Saddles will be provided within 300mm either side of each steel conduit bend or set and at a maximum distance of 900mm saddle centres for straight sections.

Where conduit boxes, accessories, etc., are situated saddles will be provided 300mm either side from the centre of the box.

The Contractor shall carefully arrange the layout of the saddles to achieve an even layout.

1.22.5 Accessory Boxes For Steel Conduit Installations

Each accessory box will be manufactured from pre-coated galvanised steel to comply with BS 4662:2006, + A1:2009 Specification for boxes for the enclosure of electrical accessories.

Each accessory box will be suitable for recessed mounting within the building structure and will be provided with ample knockouts for conduit entry.

Each accessory box will be provided with robust tapped accessory fixing lugs to accept M2.5 metric screws. One fixing lug will be adjustable to enable true alignment of the fixed accessory.

The minimum depth of all accessory boxes will be 35mm unless as instructed by the Contract Administrator.
Each accessory box will be fixed to the building structure by means of a minimum of 2 No. roundhead screws of sufficient size and length to obtain a firm fixing into the building structure with a minimum length of 32mm x No. 8 screws. The fixing screws will be zinc plated (electro-galvanised) complying with BS EN ISO 2081:2008, BS EN ISO 2082:2008 Class B coating.

All recessed accessory boxes will finish flush with the finished surface (within practical limits). Under no circumstances may the accessory box finish proud of the finished surface.
In the event that the final location of the front edge of the accessory box is 16mm or greater from the finished surface. The Contractor will supply and install an extension box to allow the accessory box to finish flush with the finished surface. The use of extension screws in these instances is prohibited.

1.23 GENERAL INSTALLATION

The conduit and conduit accessory installation for each sub-circuit and final sub-circuit will be completely erected prior to the installation of any circuit wiring.

During construction of new built projects the building will be made watertight prior to commencement of any conduit installation. Additionally circuit wiring may only be drawn into the conduit installation upon completion of the wet trades, e.g. plastering.

The conduit will be installed at least 150mm clear from all other services wherever possible and must not come into contact with water, gas, heating or steam pipework.

Where conduits are specified to be installed in voids above suspended ceilings, they shall be fixed to the structure using the recommended method of fixing, e.g. saddles.

The complete conduit system will be electrically and mechanically continuous including all boxes, etc. All conduits will be reamed clean internally to ensure freedom from burrs and other defects.

All conduits will be installed in straight lines with easy bends or sets to harmonise with the architectural features of the building.

The use of diagonal runs is prohibited; all branches will be sub-divided at right angles.

All conduits to be set will be bent cold without damaging the overall section with an approved bending machine and former. The use of manufacturer bends, etc., is prohibited unless as instructed by the Contract Administrator.

Draw in points will be spaced at a maximum of 8M centres and not more than two 90° bends (or equivalent) will be permitted.

Where conduits pass through structural floors, walls, etc., over sleeves will be provided. The sleeve will take the form of a larger size steel conduit.

Open BS boxes, etc., will be suitably protected to avoid the ingress of concrete, plaster slurry or any other material.

Running couplers will be used where absolutely necessary. All running couplers will be locked together by means of ring locknuts.

All conduits forming the couplers will be butted together inside the coupler.

In instances where a conduit is to be connected to the back of a besa box. The besa box will first be drilled clear. A male brass bush will be inserted between the box and connect onto the conduit coupler from inside the box to ensure a rigid mechanical and electrical connection is achieved.

Recognised good engineering practice shall be adopted throughout and no conduit shall run in such a way as to provide a trap for moisture or condensation. Precautions shall be taken to prevent the ingress of moisture, silt, brick and concrete chippings, etc., during and after the installation of the conduit system. Stopping plugs shall be fitted to the ends of all conduits not connected to fixing and outlet boxes. Where condensation has occurred the conduits shall be thoroughly dried by drawing swabs through them. The inside of all conduits shall be free from burrs or other obstructions.

Where conduits are installed side-by-side all "off-sets" will be similar and where "off-sets" are necessary at switch boxes, distribution boards, etc., these will be as short as practically possible.

Under no circumstances shall conduits from different distribution boards be connected at the same junction box.

The exact routes of all conduits and locations of all besa boxes, adaptable boxes and the like will be indicated on the working drawings produced by the Contractor.

Unless otherwise indicated herein, the installation shall be carried out in accordance with the IET Regulations and conform to the relevant British/European Standards.

1.24 CONCEALED CONDUIT SYSTEMS

Conduits that are to be cast in concrete floors will be laid directly above, but not in contact with, the lower steel reinforcing bars before the floors are poured. Conduits or boxes cast into structural floors will be of spout type securely fixed by the Contractor before pouring starts and all boxes will be positioned to allow for the correct thickness of finishing.

Extension rings will be used on all ceiling outlets where the box is not flush with the finished surface.

In circumstances where a terminal box would normally be used, the Contractor is to fix a through type box with the spare spout plugged with a screwed brass stop so as to provide a secure anchorage.

In special or pre-fabricated floor construction where the conduits cannot be installed as described above, they shall be run in or upon the pre-fabricated sections and 'set' down into 'loop-in' type boxes. In the case of certain pre-fabricated floors it may be necessary for the Contractor to withhold the installation until the structural cement topping on the pre- fabricated section has been laid and set. In this event, the Contractor shall, prior to the laying of the topping, mark accurately the positions of all points and down drops so that preformed holes may be left.

A space of 13mm shall be left between adjacent conduits where they are to be covered with plaster, cement or the like.

At expansion joints of cast in-situ concrete the conduit shall terminate flush at one side of the joint in a screw to slip solid coupler. From the other side of the joint the conduit shall bridge the expansion gap to engage the slip section of the coupler to allow not less than 13mm movement of the conduit without separation.

An insulated flexible earth continuity conductor of cross sectional area not less than 2.5mm^2 shall be installed within the conduit between boxes on either side of the expansion joint and secured to the back of the boxes with M2 metric phosphor bronze screws and Ross Courtney connectors.

Circular boxes shall not be used in flush systems solely for the purpose of 'drawing-in' cables except by permission of the Engineer.

Where besa boxes are recessed into the walls or ceilings and flush with the finished surfaces, the box lids will overlap the diameter of the box by not less than 6mm.

Conduits in wall chases will be secured to the building structure by means of heavy gauge crampets at least 40mm long.

1.25 FLEXIBLE METALLIC CONDUIT

Flexible metallic conduit complying with BS EN 61386-1:2008 shall be used for the final connection of the rigid conduit to the terminal boxes of machines fitted with a means of drive adjustment and/or where vibration is likely to occur.

Flexible conduit shall also be provided to semi-portable equipment such as cookers, washers and similar machines where a limited amount of movement is required for cleaning and maintenance purposes. This does not apply to small machines normally connected to socket outlets by flexible cables.

Unless specified otherwise, galvanised and non-watertight type flexible conduit shall be used under normal conditions, but watertight flexible conduit shall be used where exposed to the weather or is likely to be splashed or subjected to heavy moisture conditions.

In all instances the conduit shall be terminated in the approved type glands by being screwed and

finally hot soldered into same.

Flexible conduit will not be permitted in lieu of sets and bends in the rigid conduit system.

The flexible conduit shall be PVC sheathed, of ample capacity for the number of cables and have a minimum length of 300mm with sufficient length to allow the full range of withdrawal, adjustment or movement necessary.

1.26 PVC CONDUIT AND FITTINGS

All PVC conduit and accessories will comply with the requirements of BS 4607: Part 1:1984+ A2:2010 and Part 5:1982 + A3:2010 Specification for Rigid Conduits, Fittings & Components of Insulating Materials.

The conduit shall have a minimum size of 20mm and be rigid high impact heavy gauge grade continuous drawn type and welded into the accessories.

The method of installation will conform rigidly with the manufacturers instructions and recommendations, particularly ambient temperatures of areas where the installation is being carried out.

Bends and sets in conduits up to and including 25mm will be bent cold with the use of the correct size bending spring.

With the use of larger size conduits, the application of heat in an approved manner will be used until such times that the conduit is pliable.

All joints between conduits and accessory boxes shall be watertight and jointed by the use of PVC solvent adhesive as produced by the conduit manufactured.

Terminations of conduits into accessory boxes, etc., will be by means of female thread push in adapters and PVC male bushes, or by FAB.FIBO or equal and approved accessories. All accessory boxes, etc., will be of the metallic type with a zinc plate or aluminium finish. PVC accessory boxes will be used only as instructed by the Contract Administrator.

The Contractor shall ensure that all conduits are free from internal obstructions and the full diameter of the bore is maintained throughout its length.

Failure to comply with this requirement will mean the Contract Administrator will have the right to order the conduit installation to be dismantled and removed as far as considered necessary and replaced with new conduits. Conduit showing signs of strain or kinking shall not be installed.

Such work will be carried out by the Contractor at no cost to the Employer.

At lighting points where excessive heat may cause loss of fixings the method of attachment of the fixings shall prevent heat transmission or metal boxes shall be used and earthed via the CPC.

PVC tube ends and flexible covers will be provided to prevent the ingress of concrete plaster slurry into the conduit and fittings.

A separate circuit protective conductor will be installed in all conduit section, terminating within a purpose made earthing terminal of the accessory.

1.27 FIXINGS

The Contractor will be responsible for the fixing of all equipment and accessories which shall include the supply and installation of all rawl plugs and other plugs, bolts and rawl bolts, screws, suspensions, brackets, clamps, saddles, spacers, etc., and any other fixing whether or not specified, which may be required for the proper and effective fixing of material or equipment. The use of wooden plugs for

fixing purposes will not be permitted.

The Contractor will supply and fix all timber grounds and noggins required for the electrical installation.

Fixings by means of hardened steel pins driven in by percussion tool (HILTI or similar) or by gun fixing techniques will only be allowed where specifically agreed in writing by the Contract Administrator.

Fixings to steelwork, etc., by means of special preformed spring clips or brackets will only be carried out after approval has been obtained from the Contract Administrator steelwork must not be drilled.

Where goods or materials are supplied by Nominated Suppliers, the Contractor shall include for receiving, unloading, storing, providing adequate protection from the elements, unpacking, hoisting as necessary, assembling, positioning and fixing.

The Contractor will allow in his tender for the fixing of any wall mounted starters and control gear, etc., which may be supplied by the equipment manufacturer separate from the machines.

1.28 PAINTING - General:

Painting work connected with the Electrical Contract is to be carried out by the Contractor, except where otherwise detailed in this Specification.

Prior to handing over the installation to the painters, the Contractor is to remove all oil, dirt and other foreign matter from the conduits, equipment or plant. Failing to do so will render the Contractor liable for the cost of redecoration, should this become necessary.

Where painting is to be carried out by the Electrical Contractor due care will be taken not to mark the surrounding finishes, the paint will be applied in a professional manner. All iron and steel materials, including conduits, switchgear, brackets and accessories which show signs of rust will be wire brushed clean and painted with one coat of Jenolite rust remover and neutraliser, one coat of grey chemical sealer and one coat of red oxide paint prior to erection.

The Contractor will allow for painting the intake panel framework, trunking and all equipment mounted thereon, including all remote switchgear and controls with two coats of "NO RUSTO" aluminium finish paint as Soligmum Ltd or approved equal, and one coat of paint, colour as specified.

1.29 FINAL CIRCUITS

Every final circuit will be connected to a separate way of a fuse board, switch fuse or circuit breaker.

The wiring of each final circuit will be electrically separate from every other final circuit.

Generally, no more than two conductors may be bunched in any one terminal unless necessitated by the type of installed system, and except for ring final circuits, may more than one conductor be connected to a protective device sited within distribution equipment, i.e. consumer units etc.

Neutral conductors shall be connected to the neutral bar at the fuse board in the same order as the live conductors.

At termination points such as switch or socket outlets, etc., sufficient length must be left on cable ends to ensure that there is no tension on the connections.

The conductor insulation must be removed for a minimum length to facilitate connections and no excess length of exposed conductor shall be left.

When preparing cable ends, the Contractor shall ensure that none of the conductor strands are damaged and the strands will be twisted together with pliers to ensure a neat firm connection.

The circuit requirements are indicated on the Tender Drawings and the Contractor shall ensure that

the circuits are wired strictly in accordance with these requirements.

1.29.1 Single Phase Circuits with 3 Phase Supplies

Single-phase lighting and power circuits shall be connected on the same phase in any given area. The exception being as follows:

Where a large connected load on a common level the electrical load shall be equally balanced over the 3 phases. However, accessories and supply points on different phases shall be kept to a minimum distance of 2m apart.

Multi-gang lighting switches with 400 volts present shall be fitted with a grid clearly indicating that 400V is present. The Contractor shall however endeavour to avoid this situation wherever possible.

Where accessories are required to be on different phases within a given area this will be referred back to the Contract Administrator for clearance, and in these instances, the phase and voltage present shall be displayed on the equipment by means of an engraved traffolyte label.

Final connection of luminaires by heat resisting flexible cord/sleeving.

1.29.2 Identification of Conductors

All conductors throughout the installation shall be identified by means of durable markings which uniquely identify all conductors which make up individual circuits (eg: phase, neutral and earth for each circuit).

1.30 LUMINAIRES

The Electrical Contractor will supply, install and terminate the circuit wiring to luminaires of the type indicated by the Reference Letter or Luminaires Schedule marked on the drawing or accompanying this Specification.

All luminaires (inclusive of ceiling roses and batten holders etc.) will be inclusive of lamps.

Wiring through luminaires is prohibited unless as otherwise specified or agreed with the Contract Administrator.

1.31 LABELS AND CIRCUIT CHARTS

Labels:
All switchgear, control gear and distribution boards mounted within electrical intake cupboards/positions shall be provided with white ivorine or traffolyte labels engraved in 5mm block letters filled black, securely fixed to the equipment drilling and fixing either by PVC expanded rivets or brass headed screws and nuts.

Each label will denote the function of the equipment served. Three-phase equipment will also be labelled to denote the voltage. Labels will be as described above except lettering shall be red in colour.

In commercial intake positions the labels will denote the identification number/letter of equipment, current rating, polarity, circuit being served and description of circuit for example:

L2
60 Amp S P & N (Phase Colour)
serving D.B.3.
First Floor Landing

Labels to distribution boards shall denote the identification number/letter, number of ways, current rating, polarity, description of circuits being fed, location of supply cable, for example:

D.B.3
8 way 15 Amp S P & N (Phase Colour)
First Floor Landing served from L2

Labels shall also be provided to all remote isolators, starters and push button units to indicate the equipment being installed.

Additional labels shall be provided as specified elsewhere in this Specification.

All labels and final titles shall be approved by the Contract Administrator prior to engraving.

Circuit Charts:
A comprehensive typed Circuit Chart will be provided for each distribution board, consumers control unit installed. The Circuit Chart will detail a full description of the circuits that are being served, inclusive of fuseway number and MCB/fuse rating.

The Chart will consist of a white covered card enclosed within a transparent non-flammable PVC. or approved sheet cover, secured to the equipment by means of 4 No. brass screw fittings.

Where it is not possible to install the Charts within the distribution board, a hardwood-glazed frame will be mounted beside the board enclosing the Chart.

1.32 EARTHING AND BONDING

The whole of the electrical installation and all other equipment connected thereto will be earthed in conformity with the IET Regulations and to the requirements of the Supply Authority.

The Contractor will install a suitably sized earth copper bar, protected against corrosion for the termination of all main earth leads and main bonding cables including, where specified, earth tapes used for the earthing of the main cubicle panels and lightning protection schemes.

The earth bar fixings shall be suitably spaced off the building fabric and be complete with a removable link for testing purposes.

The incoming supply authority's earth lead either from the incoming cable sheath or service head shall be connected to the main earth bar so as to allow this earth lead to be isolated when the link is removed.

A label engraved **"Main Earthing Terminal"** will be located adjacent to the earth bars.

Where the supply authorities services exist and the main earth connection is obtained from the cable sheath. The Contractor shall ensure that the cable sheath is connected to the consumer's main earth bar by means of XL-LSF insulated cable. The size of the cable shall be dependant on the size of the supply authorities service head.

The following services where applicable shall be bonded to the main earthing terminal by means of cupinned lugs, nuts and bolts and labelled to denote size and destination:

a. Incoming gas service.
b. Incoming water service.
c. Incoming oil service.
d. Structural steel works.
e. Rising mains - hot and cold services.

f. Fire hydrant services or dry riser.
g. Lightning protection system.
h. Intake room switchgear/panels and other earth bars.

The complete trunking, tray, conduit and accommodation systems including the sheaths of all MICC cables will be electrically continuous and connected securely to all conduit boxes, switchgear and distribution boards and other electrical apparatus forming part of the installation.

The armouring and metal sheathing of all XLPE/SWA/LSF cables shall be solidly bonded together and finally connected to the panels serving the cables.

The earthing continuity of the metal sheath of each sheathed cable shall be maintained by efficient bonding of the main switch, switch fuses, distribution boards or other metal clad accessories or appliances at which the cable terminates.

If there is more than one entry of any of the above services into each building, or each separate dwelling forming part of a building, then each entry must be bonded.

The earth bonding connection will be made as near as practicable to the point of entry, except in the case of the gas service where the connection shall be on the consumers side of the meter, and must in all cases be in such a position that it shall be easily accessible for inspection.

The earth bonding lead shall be XL-LSF insulated cable coloured green/yellow and enclosed in either PVC. or HG steel conduit installed as indicated on the Drawings and Specific Specification. This cable must be of continuous length of minimum size in accordance with the relevant I.E.T Tables and the Supply Authority's requirements for PME.

All switchgear and sub-distribution panels will be bonded to earth as previously described.

Bonding clamps complying with BS 951: 2009 complete with a permanent label indelibly marked with the words **"SAFETY ELECTRICAL EARTH - DO NOT REMOVE"**, used throughout the bonding installation.

Where flat XL-LSF insulated XL-LSF sheathed wiring systems are installed the CPC will terminate directly into the outlet point.

The earthing terminal of each outlet position will be connected to the earthing terminal within the accessory box mounted thereon with a short fly with a cross sectional area equal to the circuit served circuit protective conductor.

At distribution boards the Contractor shall ensure CPCs are terminated to the correct earthing terminal corresponding to the phase and neutral connections.

Where flat XL-LSF insulated XL-LSF sheathed wiring systems are installed the CPC will terminate directly into the outlet point.

1.33 TESTS FOR HIGH VOLTAGE SYSTEMS

High voltage tests on HV cables and, where indicated, factory built assemblies and transformers shall comply with the requirements for site testing in the appropriate British Standards.

Inspection:
Works and equipment shall be inspected to ensure that it is satisfactory and safe to proceed with testing and commissioning procedures. Particular attention shall be paid to the Safety Standards for HV installations.

Testing:
Earth electrode tests shall be carried out before and after pressure testing, on both primary and secondary circuits, using a 1000-volt instrument. Tests shall be accompanied by certified copies of

Certificate of Type tests. Tests shall be in accordance with the relevant British Standards for transformers, switchgear and protective devices. Site tests shall be carried out on completion of the erection and installation of the whole of the equipment.

Consist Of The Following:

a. Operating tests, power frequency tests, millivolt drop tests complying with BS EN 62271-1:2008 + A1:2011 (latest edition and amendments).
b. Power frequency tests, millivolt drop tests complying with BS EN 60265-1:1998 (latest edition and amendments).
c. Primary and secondary injection tests.
d. Insulation resistance tests to BS 7671 (latest edition and amendments).
e. Continuity tests of inter-panel cabling.

Pressure tests applied to all main connection for a duration of one minute at a frequency of 50Hz. If tests of a longer duration are carried out, the pressures should be decreased as follows:

Duration of Test (Minutes)	Percentage of 2 x Service Voltage
1	100.0
2	83.5
3	75.0
4	70.0
5	66.6
10	60.0
15	57.7

DC Pressure tests, in accordance with Manufacturer's recommendations applied to all HV cables.

Checks to ensure correct phase sequence.

Comprehensive trip test of all equipment for all equipment at 50% services voltage, before finally making the system live.

Setting To Work:
Before commencing the setting to work procedures, a full set of certified test reports must have been completed.

Equipment shall be collectively set to work and shall include checks of control function, mechanical and electrical interlocks and relay settings.

Commissioning:
Shall consist of showing that the complete integrated system shall function in all respects as the total intent and within the design parameters.

1.34 EARTH ELECTRODE

The type of earth electrode used shall be appropriate to the soil type into which the electrode is placed.

Generally in clay type soils copper or copper clad steel rods shall be driven vertically to a minimum depth of 3 metres.

Soil containing chalk, limestone or rock sub-soil it may be necessary to lay a copper tape or cast iron/copper plates.

The earthing conductor shall not be less than 25mm x 3mm annealed copper strip.

Joints shall be made using an approved process or bolted, riveted or clamped. The Contractor shall ensure that copper jointing surfaces are twined.

Copper connections to iron earth plates shall be bolted and brazed with all bolts, rivets and clamps made of brass, bronze or similar non-ferrous material.
Joints and electrode connection shall be readily accessible and enclosed within purpose made inspection pits. Where access is not possible these joints shall be protected against moisture ingress.

Tapes shall be of soft high conductivity copper, tinned unless otherwise indicated and where fixed and liable to corrosion they shall be served with corrosion resisting tape or coated with corrosion resisting sheath. Where the tapes are run in the ground they shall be laid in sand and protected with tiles.

A removable test link shall be provided inside the building as near as possible to each earth electrode for isolation of the earth electrode for testing purposes.

The Contractor shall obtain test readings of the earth electrode in dry weather conditions and submit the results to the Contract Administrator.

Where copper tape is fixed to the building structure it shall be by means of purpose made corrosion resistant saddles. Fixings shall be made using purpose made plugs and clamps and installed at intervals not exceeding 1.0m.

All fixings shall be suitably corrosion resistant.

1.35 MANUFACTURER'S RECOMMENDATIONS

All equipment incorporated into the works shall be installed fully in accordance with the manufacturer's requirements. Upon request, the contractor shall provide the Consultant/Contract Administrator with all manufacturers Certification.

1.36 INSPECTION AND TESTING

The whole of the installation shall be inspected and tested on completion in the presence of the Contract Administrator in the manner described in the IET Regulations. The Contractor will provide the necessary labour, material and instruments for carrying out these tests and shall give the Contract Administrator seven days notice of the date it is proposed to carry out the test.

The following inspections shall be carried out during the whole of the Contract:

a. General work standard and site inspection.
b. Equipment free from rust, damage and dirt.
c. Visual inspection of electrical equipment.
d. Electrical information/literature on any equipment being installed including labelling and Circuit Charts.

Prior to any wiring being commenced earth continuity tests shall be carried out to trunking, cable tray and conduit installation to ensure that the resistance figures are acceptable. These figures shall be submitted to the Contract Administrator for acceptance.

Visual checks are to be made of overload settings of all starters which should be set in relation to the full load rating of the motors they control.

The Contractor will also allow for testing the installation whilst work is in progress, or as instructed by the Contract Administrator, and in particular the following tests must be carried out:

a. In the case of concealed sections of the installation these will be inspected and tested before

being concealed.

b. Where cables are run behind 'pinned' ceilings or buried underground, tests must be carried out immediately after the ceiling is fixed and before decorations commence.

c. Inspection and testing of conduits and trunking as previously specified.

d. Testing of MICC cables as previously specified.

When the Supply Authority Board requires a Certificate of Tests as a condition of accepting an installation or part thereof for final connection to the supply, the Contractor will furnish such test certificates direct to the Board and forward a copy to the Contract Administrator.

The following sequence of events shall be carried out:

e. Setting the plant to work.

f. Inspection of the plant under operating conditions.

g. Electrical tests on motors and generators and for ensuring the correct phase rotation of the three phase output from standby generation plant with that of the mains.

h. Demonstration to the Engineer of the proper operation of the plant and the control and safety devices under any fault condition.

i. During the execution of the works by the Contractor and on completion (and if considered necessary at the end of the defects liability period) the work shall be inspected by the Contract Administrator for compliance with the Specification.

j. The tests executed in the presence of the Contract Administrator as detailed in the IET Wiring Regulations are as follows:

- Continuity of protective conductors including main and supplementary bonding.
- Continuity of ring circuit conductors.
- Insulation resistance.
- Site applied insulation.
- Protection by separation of circuits.
- Protection by barriers or enclosures provided during erection.
- Insulation of non-conducting floors and walls.
- Polarity.
- Earth loop impedance.
- Earth electrode resistance.
- Operation of residual current devices

k. At the discretion of the Contract Administrator a full load test (1 hour). During this test allow for taking voltage and current readings at the final circuit, sub-main and main intake positions.

l. The Contractor will submit the results of the tests to the Contract Administrator within seven days of the date of testing.

1.37 OPERATING AND MAINTENANCE

In compliance with the Health and Safety at Work Act 1974 the persons in charge of the building or appointed representatives of the Client shall be instructed in the correct operation, control and maintenance of the systems and components.

Operating and Maintenance Instructions, purpose written for these particular works in accordance with the BSRIA Guide BG 1/2007 “Handover operating and Maintenance Manuals and project feed back” shall be provided. The manuals shall be based on the Class ‘D’ standards and be divided into the following sections:

Introduction/Format of the Manual:

Section 1	How to use the Manual
Section 2	Contractual and Legal guides
Section 3	Design intent/parameters
Section 4	Description of systems
Section 5	Schedules of systems
Section 6	Spare parts
Section 7	Spares policy
Section 8	Commissioning data
Section 9	Operation of systems
Section 10	Maintenance and fault finding
Section 11	Modification information
Section 12	Disposal instructions
Section 13	Names and addresses of manufacturers
Section 14	“As Installed” drawings
Section 15	Emergency information
Section 16	Manufacturer’s literature

Particular attention must be given to detailing the controls strategies, testing durations, maintenance schedules (every day, every week every month, every three months, every six months, every year etc.). Manufacturer’s maintenance publications must be included in the manuals.

Three complete sets of the approved instructions secured inside good quality hard cover ring binders of adequate size shall be produced and made available at Practical Completion of the works. Two sets shall be handed to the Client and one set issued to the CDM-C for inclusion in the Health and Safety File.

The installations will not be accepted by the client until the approved manuals have been provided.

1.38 HANDOVER

The Contractor shall prior to completion:

a. Supply all test certificates of plant items from manufacturer.
b. Supply all test certificates covering the works during installation and any special tests certified by the Insurance Company.
c. Supply schedule equipment installed.
d. Supply operating and maintenance instructions and drawings for the proper working of the whole installation.
e. Supply adequate information for inclusion in the Building Log Book.
f. Supply of adequate instructions on safety precautions under fault conditions.
g. Supply a list of names, addresses and telephone numbers of all contracting firms and manufacturing firms responsible for the installation or supply of equipment items comprising the Contract Works.
h. Supply spares as indicated and/or makers recommended list of spares.
i. Make sure all plant items clearly show actual manufacturers nameplate giving plant details, reference numbers, duty and date of manufacture.
j. Attend to the general finishing of installation.
k. Agree with Contract Administrator a list of defects and rectify such defects.
l. Supply accessory, plant and equipment keys in duplicate.

m. Supply Health and Safety File for the works in its entirely (where applicable).